ALPHA-PINENE
CASRN: 80-56-8

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Best Sections

Special Reports :
European Chemicals Bureau; IUCLID Dataset, Pin-2(3)-ene (**80**-**56**-**8**) 62 pp. (2000 CD-ROM edition). Available from the Database Query page at: http://ecb.jrc.it/esis/esis.php as of October **8**, 2008.

Plant Concentrations :
alpha-Pinene was identified in chamise shrubs (Adenostoma fasciculatum)(1). It was identified in 16 of 82 wild mushroom species(2). The normalized emission rate of alpha-pinene from mature spruce was 0.25 (Pinus glauce), 0.85 (P. Abies), and 0.34 (P. pungens) ug C/g-hr(3). The emission rates of alpha-pinene from loblolly pine, shortleaf pine, sweet gum, willow, elm, cypress, water hickory, hackberry, maple, and red oak were 2300, 7000, 45000, **80**, 1300, 5700, 12000, 50, 5300, and 40 ug/kg-foliage/hr, respectively(4). The mean emission rate of alpha-pinene from sunflower (Helianthus annus L. cv. gigantues) was 6.2X10-16 mol/cu cm-s(5). It was identified as an emission from California agricultural plants(6). alpha-Pinene exhibited seasonal emission variations in Australian Eucalyptus globulus trees sampled under natural growing conditions from June 1996 to May 1997. Monthly average percentages beginning with May and sampled for the following 11 months were: 64; 47; 82; 60; **56**; 62; 50; 62; 62; 59; 44; and 65%(7). Sampling was conducted in the Scandanavian boreal zone in Asa Research Park, Sweden and Mekrijarvi Research Station, Finland in the spring and summer of 1997; percent emission composition from Scots pine at Asa and Mekrijarvi were 35 and 63% for alpha-pinene, respectively(**8**). alpha-Pinene was detected, not quantified in ambient air around Pinus halepensis trees located in Bab-Ezzouar, a suburb of Algiers, and in Eucalyptus globulus and Cedrus atlantica trees from El-Hamma Botanical Garden, Algiers(9).
[(1) Arey J et al; J Geophys Res 96: 9329-36 (1991) (2) Breheret S et al; J Agric Food Chem 45: 831-6 (1997) (3) Kempf K et al; Atmos Environ 30: 1381-89 (1996) (4) Khalil MAK, Rasmussen RA; J Air Waste Manag Assoc 42: 810-3 (1992) (5) Schuh G et al; J Atmos Chem 27: 291-318 (1997) (6) Winer AM et al; Atmos Environ 26A: 2647-59 (1992) (7) He C et al; Chemosphere - Global Change Sci 2: 65-76 (2000) (8) Janson R, Deserves C; Atmos Environ 35: 4629-37 (2001) (9) Yassaa N et al; Atmos Environ 34: 2809-16 (2000)] **PEER REVIEWED**

Human Toxicity Excerpts :
/SURVEILLANCE/ ... To study work exposure and respiratory symptoms in New Zealand plywood mill workers ... personal inhalable dust (n = 57), bacterial endotoxin (n

= 20), abietic acid (n = 20), terpene (n = 20) and formaldehyde (n = 22) measurements were taken and a respiratory health questionnaire was administered to 112 ... workers. ... Twenty-six percent of the dust exposures exceeded 1 mg/cu m, however, none of the samples exceeded the legal limit of 5 mg/cu m (geometric mean (GM) = 0.7 mg/cu m, geometric standard deviation (GSD) = 1.9). Workers in the composer area (where broken sheets are joined together) were significantly (P < 0.01) more highly exposed. Endotoxin levels were low to moderate (GM = 23.0 EU/cu m, GSD = 2.**8**). Abietic acid levels ranged from 0.3 to 2.4 ug/cu m (GM = 0.7 ug/cu m, GSD = 1.**8**) and were significantly (P < 0.05) higher for workers in the composer area of the process. Geometric mean levels of alpha-pinene, beta-pinene and Delta(3)-carene were 1.0 (GSD = 2.7), 1.5 (GSD = 2.**8**) and 0.1 (GSD = 1.4), respectively, and alpha-pinene and beta-pinene levels were significantly (P < 0.001) higher for workers in the 'green end' of the process, up to and including the veneer dryers. Formaldehyde levels ranged from 0.01 to 0.74 mg/cu m (GM = 0.08 mg/cu m (= 0.06 ppm), GSD = 3.0). Asthma symptoms were more common in plywood mill workers (20.5%, n = 112) than in the general population (12.8%, n = 415, adjusted OR (95% CI) = 1.5 (0.9-2.**8**)). Asthma symptoms were associated with duration of employment and were reported to lessen or disappear during holidays. No clear association with any of the measured exposures was found, with the exception of formaldehyde, where workers with high exposure reported more asthma symptoms (36.4%) than low exposed workers (7.9%, adjusted OR (95% CI) = 4.3 (0.7-27.7))... [Fransman W et al; Ann Occup Hyg 47 (4): 287-95 (2003)] **PEER REVIEWED** PubMed Abstract

Non-Human Toxicity Excerpts :

/LABORATORY ANIMALS: Developmental or Reproductive Toxicity/ Virgin adult female hamsters were individually housed in mesh-bottom cages in a temperature- and humidity-controlled room. Animals were given free access to food and fresh tap water. There were mated one to one with untreated adult males and the appearance of motile sperm in the vaginal sperm was considered day 0 of gestation. Beginning on Day 6 and continuing daily through Day 10 of gestation, females were given 0, 6, 28, 130, or 600 mg/kg bw of the test material /a mixture of 85-90% terpene hydrocarbons and < 10% oxygenated terpene hydrocarbons/ by gavage in corn oil. A positive control group received 250 mg/kg bw/day of aspirin. Body weights were recorded on days 0, **8**, 10, and 14 of gestation. Females were observed daily for appearance and behavior. Food consumption and body weight were monitored to eliminate any abnormalities that may be associated with anorexia in pregnant females. On Day 14 all dams were subjected to Caesarian section and the number of implantation sites, resorption sites, live fetuses, dead fetuses, and body weight of live pups were recorded. Gestation index, mortality, gross pathology incidence of the dam urogenital tract, number of implantation sites, number of corpora lutea, litter size and weights, sex and sex ratio of pups, and gross abnormalities to pups were reported. The urogenital tract of each dam was examined for anatomical abnormalities. One-third of fetuses of each litter underwent detailed visceral examination at 10x magnification. The remaining two-thirds were stained with alizarin red S dye/KOH and examined for skeletal defects. Parental data and F1 as Appropriate: Data for number of females mated/pregnant at each dose level: 0 mg/kg bw, 27/21; 250 mg/kg bw of aspirin, 26/19; 6 mg/kg bw, 28/19; 28 mg/kg bw, 26/21; 130 mg/kg bw, 28/20; 600

mg/kg bw, 27/23. All pregnant females survived to sacrifice on Day 14. There was no significant difference in dam body weights between controls and any test group measured at Days 0, 6, **8**, 10, or 14 of the study. One death each was reported in the two control groups and in the two highest dose groups before day 14. All litters were alive on Day 14 sacrifice. Average number of corpora lutea/dam mated were similar for controls and treatment groups: 0 mg/kg bw, 10.3; 250 mg/kg bw aspirin, 9.9; 6 mg/kg bw, 9.6; 28 mg/kg bw, 11.4; 130 mg/kg bw, 9.6; 600 mg/kg bw, 11.2. The average number of implantation sites/dam and % partial resorptions were similar for all groups:0 mg/kg bw, 11.7 and 15%; 250 mg/kg bw aspirin, 11.3 and 39%; 6 mg/kg bw, 12.1 and 32%; 28 mg/kg bw, 11.9 and 38%; 130 mg/kg bw, 11.5 and 42%; 600 mg/kg bw, 12.1 and 23%. Based on body weight changes, clinical observation, and gross examination of the urogenital tract, was no evidence of toxicity to dams. Offspring Toxicity - F1 and F2: Based on gross examination of live pups, visceral examination, and skeletal examination there were no signs of toxicity to offspring in either the control or test groups. The total number of live fetuses, average number of live fetuses per dam, sex ratio, and average fetal weight were not different between control and treatment groups. A small number of dead fetuses were reported at the three highest dose levels. The incidence of mortality was not dose related. Total number of live fetuses/dead fetuses/average fetal weight are recorded below: 0 mg/kg bw, 229/0/1.76g; 250 mg/kg bw aspirin, 192/0/1.74g; 6 mg/kg bw, 217/0/1.66g; 28 mg/kg bw, 230/7/1.73g; 130 mg/kg bw, 195/5/1.72g; 600 mg /kg bw, 258/1/1.70g.
[USEPA; High Production Volume Information System (HPVIS). Detailed Chemical Results Chemical Name: Bicyclo[3.1.1]hept-2-ene, 2,6,6-trimethyl- CAS Number: 80-56-8. Available from, as of October 8, 2008: http://iaspub.epa.gov/oppthpv/quicksearch.display?pChem=101069 **PEER REVIEWED**

Non-Human Toxicity Excerpts :
/LABORATORY ANIMALS: Developmental or Reproductive Toxicity/ The test substance was administered orally by gavage /to Sprague-Dawley rats/ at the dose levels specified or the vehicle alone once daily for six days from the 9th to 14th day of gestation. All dams were necropsied and examined for gross lesions on Day 20. Maternal data with dose level: No significant differences were reported for maternal body weight gain, number of implantations, placental weight, intrauterine mortality and fetal weight for the 0.16 mL/kg (137.6 mg/kg) and 0.**8** mL/kg (688 mg/kg) dose levels. At the 1.6 mL/kg (860 mg/kg) dose level, significant maternal weight loss and placental and fetal weight loss were reported. Fetal Data with Dose Level: No gross, visceral or skeletal anomalies were reported at the highest dose level. Malformations were reported in the 0.16 mL/kg (137.6 mg/kg) dose group and the control group, but the differences between the two were not significant. No effect on postnatal development was reported for the 0.16 mL/kg (137.6 mg/kg) and 0.**8** mL/kg (688 mg/kg) dose levels. Newborn body weight showed significant decrease at the 1.60 mL/kg (860 mg/kg) dose level, but development recovered within one week.
[USEPA; High Production Volume Information System (HPVIS). Detailed Chemical Results Chemical Name: Bicyclo[3.1.1]hept-2-ene, 2,6,6-trimethyl- CAS Number: 80-56-8. Available from, as of October 8, 2008: http://iaspub.epa.gov/oppthpv/quicksearch.display?pChem=101069 **PEER

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Non-Human Toxicity Excerpts :

/IMMUNOTOXICITY/ The popliteal lymph node assay (PLNA) has been proposed as a screening test for detecting chemicals with potential of inducing allergic and auto-immune-like reactions in humans. ... The present study ... used the rat PLNA to evaluate the immuno-sensitizing potential of 10 monoterpenes found in the essential oils of a variety of aromatic, edible and medicinal plants. The primary or direct PLNA was performed with the monoterpenes, and chlorpromazine (CPZ) and barbital were used as positive and negative controls, respectively. Female, 7-**8** week-old Wistar rats were injected subcutaneously (50 uL) with the test substance (0.5, 2.5 or 5 mg) into the right hind footpad while the contralateral footpad was injected with the vehicle (DMSO) alone. Weight (WI) and cellularity (CI) indices for draining PLNs were determined 7 days after treatment. PLNA was positive (WI >or= 2 and CI >or= 5) for CPZ, citral, alpha-terpinene, beta-myrcene and (-)-alpha-pinene, and negative for barbital, DMSO, (-)-menthol, 1,**8**-cineole, (+/-) citronellal, (+)-limonene, (+/-) camphor and terpineol. A secondary PLNA, a T-cell priming test, was carried out with the four substances that had been positive in the primary assay. Six weeks after being locally primed with 5 mg/paw, rats were sc injected into the same footpad with a dose (0.5 mg/paw) of the substance that had been previously found to be insufficient to cause a positive response. WI and CI were then calculated 4 and 7 days after the second injection. CPZ was also positive in the secondary assay thereby confirming that it is a sensitizing agent. Citral, alpha-terpinene, beta-myrcene and (-)-alpha-pinene, however, were negative in the secondary assay. In summary, citral, alpha-terpinene, beta-myrcene and (-)-alpha-pinene induced a clear immuno-stimulatory response due to their irritant properties but no monoterpene proved to be a sensitizing agent in the PLNA.

[Friedrich K et al; Food Chem Toxicol 45 (8): 1516-22 (2007)] **PEER REVIEWED** PubMed Abstract

Metabolism/Metabolites :

The biotransformation of (+)-, (-)-, and (+-)-alpha-pinenes, (-)-beta-pinene (nopinene), (-)-cis-pinane, (+)-3-carene, (-)-cis-carane, myrcene, and p-cymene in rabbits was investigated. The major metabolites were as follows: (-)-trans-verbenol from (+)-, (-)-, and (+/-)-alpha-pinenes; (-)-10-pinanol and (-)-1-p-menthene-7,**8**-diol from (-)-beta-pinene; (-)-alpha-terpineol and (-)-trans-sobrerol from (-)-cis-pinane; (-)-m-mentha-4,6-dien-**8**-ol, 3-caren-9-ol, (-)-3-carene-9-carboxylic acid, and 3-carene-9,10-dicarboxylic acid from (+)-3-carene; carane-9,10-dicarboxylic acid from (-)-cis-carane; and myrcene-3(10)-glycol, myrcene-1,2-glycol, uroterpenol, and p-cymene-9-carboxylic acid from p-cymene. These metabolisms include allylic oxidation, epoxidation, stereoselective gem-dimethyl hydroxylation and its oxidation, cleavage of a conjugated double bond by epoxidation, and regioselective oxidation, some of which are not found usually in chemical reactions, and due to which various new compounds were determined. This biotransformation of the monoterpene hydrocarbons gave some insect pheromones in high yield.

[Ishidata T et al; J Pharm Sci 70 (4): 406-15 (1981) Apr;70(4):406-15]

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Environmental Abiotic Degradation :

The rate constant for the vapor-phase reaction of alpha-pinene with photochemically-produced hydroxyl radicals is 5.37X10-11 cu cm/molecule-sec at 25 deg C(1). This corresponds to an atmospheric half-life of about 7 hrs at an atmospheric concentration of 5X10+5 hydroxyl radicals per cu cm(2). The rate constant for the vapor-phase reaction of alpha-pinene with ozone has been estimated as 4.3X10-18 cu cm/molecule-sec at 25 deg C(SRC) that was derived using a structure estimation method(2). This corresponds to an atmospheric half-life of about 38 minutes at an atmospheric concentration of 7X10+11 ozone molecules per cu cm(3). Products from the reaction of alpha-pinene with ozone are carbon monoxide, carbon dioxide, formaldehyde, acetaldehyde, formic acid, peroxyacetylnitrate, cis-pinonic acid, nopinene, acetone, pionaldehyde, glyoxal, and hydroxyl radicals(4-7). The rate constant for the night-time, vapor-phase reaction of alpha-pinene with nitrate radicals is 5.8X10-12 cu cm/molecule-sec at 25 deg C(**8**). This corresponds to an atmospheric half-life of about 6 minutes at an atmospheric concentration of 5X10+**8** nitrate radicals per cu cm(9). The reaction of alpha-pinene with nitrate radicals yields 3-acetyl-2,2-dimethyl cyclobutane acetaldehyde, pinane epoxide, 3-oxypinane-2-nitrate, and 2-hydroxy-3-nitrate(10). Calculated half-lives of 4.6 hrs for reaction with ozone and 11 minutes for reaction with nitrate have also been reported(11). alpha-Pinene is not expected to undergo hydrolysis in the environment due to the lack of functional groups that hydrolyze under environmental conditions(12). alpha-Pinene does not contain chromophores that absorb at wavelengths >290 nm(12) and therefore is not expected to be susceptible to direct photolysis by sunlight(SRC).

[(1) Kwok ESC, Atkinson R; Estimation of hydroxyl radical reaction rate constants for gas-phase organic compounds using a structure-reactivity relationship: an update. Riverside, CA: Univ CA, Statewide Air Pollut Res Ctr. CMA Contract No. ARC-8.0-OR (1994) (2) Meylan WM, Howard PH; Chemosphere 26: 2293-99 (1993) (3) Atkinson R, Carter WPL; Chem Rev 84: 437-70 (1984) (4) Hooker CL et al; J Atmos Chem 2: 307-20 (1985) (5) Chew AA, Atkinson R; J Geophys Res 101: 28649-53 (1996) (6) Hakola H et al; J Atmos Chem 18: 75-102 (1994) (7) Grosjean D et al; Environ Sci Technol 26: 1526-33 (1992) (8) Atkinson R, Carter WP; Chem Rev 84: 437-70 (1984) (9) Kwok ESC et al; Environ Sci Technol 30: 329-34 (1996) (10) Wangberg I et al; Environ Sci Technol 31: 2130-35 (1997) (11) Atkinson R, Arey J; Atmos Environ 37: S197-S219 (2003) (12) Lyman WJ et al; Handbook of Chemical Property Estimation Methods. Washington, DC: Amer Chem Soc pp. 7-4, 7-5, 8-12 (1990)] **PEER REVIEWED**

Effluent Concentrations :

The emission rate of alpha-pinene from particle board was 0.0068 mg/sq m-hr(1). It was qualitatively detected as an emission from cologne and soap(2) and particle board furniture(3). alpha-Pinene was detected as an emission from 12 of 31 cologne products(6). The emission rate of alpha-pinene from particle board and rubber molding was 25 and 2.1 ug/cu m-hr, respectively(4). Mean residential wood combustion emissions using softwood and hardwood from Denver, CO were dtermined; emissions from a fireplace were 54.65 and 3.38 mg/kg, respectively; emission from a wood stove using

hard wood was 4.10 mg/kg of fuel(5). Emissions from two oiled parquets floor coverings were 14 and 10 ug/sq m-hr after 3 and 28 days following installation, respectively; 341 and 286 ug/sq m-hr, respectively, from waxed parquets; 15 and **8** ug/sq m-hr, respectively, from varnished parquets(7). Emissions from new and old linoleum floorings were zero and 1 ug/sq m-hr, respectively(7). alpha-Pinene has been identified as a volatile organic ingredient of wood-based furniture with its possible source being an ecological coating system based on natural resins, nitrocellulose, and/or softwood construction(**8**).
[(1) Colombo A et al; Sci Total Environ 91: 237-49 (1990) (2) Cooper SD et al; J Exposure Anal Environ Epidemio 5: 57-75 (1995) (3) Salthammer T; Indoor Air 7: 189-97 (1997) (4) Sheldon LS et al; pp. 2-16 in Proc APCA Ann Mtng 79th (vol 4) 86/52.2 (1986) (5) McDonald JD et al; Environ Sci Technol 34: 2080-91 (2000) (6) Wallace LA et al; Identification of Polar Volatile Organic Compounds in Consumer Products and Common Microenvironments. NTIS PB91-182065 (1991) (7) Saarela K; pp 185-202 in Organic Indoor Air Pollutants. Salthammer T, ed., New York, NY: Wiley-VCH (1999) (8) Salthammer T; pp. 203-18 in Organic Indoor Air Pollutants. Salthammer T, ed., New York, NY: Wiley-VCH (1999)] **PEER REVIEWED**

Human Toxicity Excerpts :
/CASE REPORTS/ ... 24 cases of hand dermatitis in pottery workers involved in ceramic decoration, paintresses, liners, gilders, enamellers and a fine china painter, /were/ seen in a 6-month period following a change from Portuguese to Indonesian turpentine, of whom 14 were sensitive to Indonesian turpentine, **8** to alpha-pinene, 4 to delta-3-carene and 2 positive to turpentine peroxides. Previous reports suggest that delta-3-carene is the main allergen and reports of sensitivity to alpha-pinene in the absence of sensitivity to turpentine peroxide, in particular to the hydroperoxide of delta-3-carene, are few. ... alpha-Pinene, an unusual allergen, appears to be the most common in /this study/. Reversion to Portuguese turpentine seems to have alleviated the problem.
[Lear JT et al; Contact Dermatitis 35 (3): 169-72 (1996)] **PEER REVIEWED** PubMed Abstract

Non-Human Toxicity Excerpts :
/LABORATORY ANIMALS: Developmental or Reproductive Toxicity/ In the study, virgin adult female hamsters were individually housed in mesh bottom cages in a temperature- and humidity-controlled room. Animals were given free access to food and fresh tap water. There were mated one to one with untreated young adult males and the appearance of motile sperm in the vaginal sperm was considered day 0 of gestation. Beginning on Day 6 and continuing daily through Day 10 of gestation, groups (19-23/group) of pregnant females were given 0, 6, 28, 130, or 600 mg/kg bw of the test material by gavage in corn oil. A positive control group received 250 mg/kg bw/day of aspirin. Body weights were recorded on days 0, 6, **8**, 10, and 14 of gestation. Females were observed daily for appearance and behavior. Food consumption and body weight were monitored to eliminate any abnormalities that may be associated with anorexia in pregnant females. On Day 14 all dams were subjected to Caesarian section and the number of implantation sites, resorption sites, live fetuses, dead fetuses, and body weight

of live pups were recorded. Gestation index, mortality, gross pathology incidence of the dam urogenital tract, number of implantation sites, number of corpora lutea, litter size and weights, sex and sex ratio of pups, and gross abnormalities to pups were reported (these data were described in the robust summary for reproductive effects for the test material). The urogenital tract of each dam was examined for anatomical abnormalities. One-third of fetuses of each litter underwent detailed visceral examination at 10x magnification. The remaining two-thirds were stained with alizarin red S dye/KOH and examined for skeletal defects (the maternal and developmental fetal effects are discussed in this robust summary). Actual dose received by dose level and sex: 0, 6, 28, 130, or 600 mg/kg bw of the test material (FDA 71-28) Maternal data with dose level: Daily clinical observation and measurement of body weight gain failed to show any differences between control and test groups of female rats. The number pregnant and % pregnancy were similar for all dose and control groups. One pregnant female died in each of the two control groups and the two highest dose groups in the study. No abortions were observed in any group. Fetal Data with Dose Level: The average fetal weight of treatment and control groups were not statistically different ($p>0.05$). The total number of live fetuses was similar for test and control groups. A small % of (less than 3%) dead fetuses were observed at the three highest dose levels. Skeletal examination of sternebrae showed no significant differences in the incidence of incomplete ossification or missing sternebrae for test and control groups. Likewise the incidences of fetuses with more than 13 ribs, incomplete ossification of vertebrae and extremities, incomplete skull closures were similar for test and control animals. Visceral examination failed to reveal any evidence of abnormalities at any dose level.
[USEPA; High Production Volume Information System (HPVIS). Detailed Chemical Results Chemical Name: Bicyclo[3.1.1]hept-2-ene, 2,6,6-trimethyl- CAS Number: 80-56-8. Available from, as of October 8, 2008: http://iaspub.epa.gov/oppthpv/quicksearch.display?pChem=101069 **PEER REVIEWED**

Ecotoxicity Values :
LC50; Species: Daphnia magna (Water flea, age <24 hr); Conditions: freshwater, static, 22 deg C, pH **8**.0 (7.4-9.4), hardness 173 mg/L CaCO3, dissolved oxygen >60%; Concentration: 68000 ug/L for 24 hr (95% confidence interval: 24000-190000 ug/L) /commercial grade >80% /
[LeBlanc GA; Bull Environ Contam Toxicol 24 (5): 684-91 (1980) Available from, as of August 26, 2008: http://cfpub.epa.gov/ecotox/quick_query.htm **PEER REVIEWED**

Ecotoxicity Values :
LC50; Species: Daphnia magna (Water flea, age <24 hr); Conditions: freshwater, static, 22 deg C, pH **8**.0 (7.4-9.4), hardness 173 mg/L CaCO3, dissolved oxygen >60%; Concentration: 41000 ug/L for 48 hr (95% confidence interval: 27000-62000 ug/L) /commercial grade >80% /
[LeBlanc GA; Bull Environ Contam Toxicol 24 (5): 684-91 (1980) Available from, as of August 26, 2008: http://cfpub.epa.gov/ecotox/quick_query.htm **PEER REVIEWED**

Ecotoxicity Values :
LC50; Species: Daphnia magna (Water flea); Conditions: freshwater, static, 20.1 deg C, pH 7.90 + or -0.05, oxygen concentration **8**.2 mg/mL; Concentration: 1.44 mg/L for 48 hr /98% pure 1R(+)-isover. Measured purity 91%/
[USEPA; High Production Volume Information System (HPVIS). Detailed Chemical Results Chemical Name: Bicyclo[3.1.1]hept-2-ene, 2,6,6-trimethyl- CAS Number: 80-56-8. Available from, as of October 13, 2008: http://iaspub.epa.gov/oppthpv/quicksearch.display?pChem=101069 **PEER REVIEWED**

Ecotoxicity Values :
LC50; Species: Chaetogammarus marinus (aquatic arthropod); Conditions: sea water, semi-static, 15 deg C, pH **8**.0; Concentration: 2.6 mg/L for 24 hr
[European Chemicals Bureau; IUCLID Dataset, Pin-2(3)-ene (80-56-8) p.23 (2000 CD-ROM edition). Available from, as of October 13, 2008: http://ecb.jrc.ec.europa.eu/esis/ **PEER REVIEWED**

Ecotoxicity Values :
LC50; Species: Chaetogammarus marinus (aquatic arthropod); Conditions: sea water, semi-static, 15 deg C, pH **8**.0; Concentration: 1 mg/L for 96 hr
[European Chemicals Bureau; IUCLID Dataset, Pin-2(3)-ene (80-56-8) p.23 (2000 CD-ROM edition). Available from, as of October 13, 2008: http://ecb.jrc.ec.europa.eu/esis/ **PEER REVIEWED**

Absorption, Distribution & Excretion :
The toxicokinetics of alpha-pinene (a-pinene) were studied in humans. The study group consisted of eight healthy males, average age 31 years. They were exposed to 0, 10, 225, or 450 mg/cu m (+)-alpha-pinene or 450 mg/cu m (-)-alpha-pinene for 2 hr in an inhalation chamber. During exposure they exercised on a cycle ergometer at the rate 50 watts. Average pulmonary uptake of (+)-alpha-pinene and (-)-alpha-pinene amounted to 59% of the exposure concn. Absolute uptake increased linearly with concn. Blood alpha-pinene concn increased rapidly at first then tapered off. Mean blood concn at the end of exposure were linearly related to inhaled concn. Elimination of alpha-pinene from the blood was triphasic. Half times for elimination of inhaled (+)-alpha-pinene from the blood during the three phases were 4.**8**, 39, and 695 minutes. Elimination half times fo (-)-alpha-pinene were 5.6, 40, and 555 minutes. Cumulative urinary excretion of unchanged alpha-pinene amounted to less than 0.001% of each dose. Respiratory elimination of (+)-alpha-pinene and (-)-alpha-pinene was 7.7 and 7.5% of total uptake, respectively. Five subjects complained of eye, nose, and throat irritation. No exposure related changes in lung function were seen. At the concn tested the capacity of the liver to metabolize alpha-pinene is not exceeded. (+)-alpha-Pinene and (-)-alpha-pinene show similar pharmacokinetic behavior. alpha-Pinene is readily metabolized and elimination of unchanged alpha-pinene is very low.
[Falk AA et al; Scand J Work Environ Health 16 (5): 372-8 (1990)]

PEER REVIEWED PubMed Abstract

Absorption, Distribution & Excretion :
... Eight male volunteers were exposed to 450 mg/cu m turpentine by inhalation (2 hr, 50 W) in an exposure chamber. ...The mean relative uptakes of alpha-pinene, beta-pinene, and 3-carene were 62%, 66%, and 68% respectively, of the amount supplied. Between 2% and 5% of the net uptake was excreted unchanged in the expired air after the end of exposure. The mean blood clearance 21 hours after exposure (CL21hr) of alpha-pinene, beta-pinene and 3-carene, were 0.**8**, 0.5, and 0.4 l.per kg per hr, respectively. The mean half lives (t1/2) of the last phase of alpha-pinene, beta-pinene, and 3-carene averaged 32, 25, and 42 hours, respectively. The t1/2s agreed with previously calculated half lives from single exposures. The total blood clearance CL21hr of 3-carene found in this turpentine study was lower, and CL4hr of 3-carene was significantly lower than the values obtained from similar exposure to pure 3-carene. The subjects attending both exposure to turpentine and to pure alpha-pinene at 450 mg/cu m had lower CL4hr during the exposure to turpentine ... Toxicokinetics ... show small, if any, interactions between alpha-pinene, beta-pinene, and 3-carene...
[Filipsson AF; Occup Environ Med 53 (2): 100-5 (1996)] **PEER REVIEWED** PubMed Abstract

Biological Half-Life :
... Half times for elimination of inhaled (+)-alpha-pinene from the blood during the three phases were 4.**8**, 39, and 695 minutes. Elimination half times of (-)-alpha-pinene were 5.6, 40, and 555 minutes ...
[Falk AA et al; Scand J Work Environ Health 16 (5): 372-8 (1990)] **PEER REVIEWED** PubMed Abstract

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[Filipsson AF; Occup Environ Med 53 (2): 100-5 (1996)] **PEER REVIEWED** PubMed Abstract

Natural Pollution Sources :
alpha-Pinene is a naturally occurring terpene which is a constituent of many volatile oils(1). Total US emission of alpha-pinene from deciduous and coniferous forests amounted to 6.6 mega tons annually(2). An estimated emission rate of alpha-pinene from natural sources to the atmosphere is 1.84X10-10 g/sq cm/sec(3). alpha-Pinene is a component of trees, fruits, grasses, bushes, fungi, herbs, and flowers(4-**8**).
[(1) O'Neil MJ, ed; The Merck Index. 14th ed. Whitehouse Station,NJ:

Merck And Co, Inc p. 1283 (2001) (2) Lamb B et al; Atmos Environ 21: 1695-705 (1987) (3) Graedel TE, Allara DL; pp. 467-73 in Int Conf Photochem Oxid Pollut Control Proc: Vol. 1. USEPA, Off Res Dev USEPA-600/3-77-001a, NTIS PB-264 232 (1977) (4) Altshuller AP; Atmos Environ 17: 2131-65 (1983) (5) Arey J et al; J Geophys Res 96: 9329-36 (1991) (6) Khalil MAK, Rasmussen RA; J Air Waste Manag Assoc 42: 810-3 (1992) (7) Schuh G et al; J Atmos Chem 27: 291-318 (1997) (8) Chung TY et al; J Agric Food Chem 41: 1693-7 (1993)] **PEER REVIEWED**

Environmental Fate :

AQUATIC FATE: Based on a classification scheme(1), an estimated Koc value of 2,600(SRC), determined from a log water solubility of 2.49 mg/L(2) and a regression-derived equation(3), indicates that alpha-pinene is expected to adsorb to suspended solids and sediment(SRC). Volatilization from water surfaces is expected(3) based upon an estimated Henry's Law constant of 0.29 atm-cu m/mole(SRC), derived from its vapor pressure, 4.75 mm Hg(4), and water solubility(2). Using this Henry's Law constant and an estimation method(3), volatilization half-lives for a model river and model lake are 3 hours and 5 days, respectively(SRC). However, volatilization from water surfaces is expected to be attenuated by adsorption to suspended solids and sediment in the water column. The estimated volatilization half-life from a model pond is 207 days if adsorption is considered(5). According to a classification scheme(6), an estimated BCF of 1,040(SRC), from its log Kow of 4.83(2) and a regression-derived equation(7), suggests the potential for bioconcentration in aquatic organisms is very high, provided the compound is not metabolized by the organism(SRC). alpha-Pinene reached 95% of its theoretical BOD using activated sludge in the Japanese MITI test(**8**), suggesting that biodegradation is an important environmental fate process in water(SRC).
[(1) Swann RL et al; Res Rev 85: 17-28 (1983) (2) Li J, Perdue EM; Physicochemical properties of selected monoterpenes. Pre-print extended abstract, Presented before the Division of Environmental Chemistry, Amer. Chem. Soc., Anaheim, CA, April 2-7, 1995 (1995) (3) Lyman WJ et al; Handbook of Chemical Property Estimation Methods. Washington, DC: Amer Chem Soc pp. 4-5, 15-1 to 15-29 (1990) (4) Daubert TE, Danner RP; Physical and Thermodynamic Properties of Pure Chemicals Data Compilation. Washington, DC: Taylor and Francis (1989) (5) US EPA; EXAMS II Computer Simulation (1987) (6) Franke C et al; Chemosphere 29: 1501-14 (1994) (7) Meylan WM et al; Environ Toxicol Chem 18: 664-72 (1999) (8) Chemical Risk Information Platform (CHRIP). Biodegradation and Bioconcentration. Ver 2006.01.30 Updated. National Institute of Technology and Evaluation. Tokyo, Japan. alpha-Pinene (80-56-8). Available from the database query page at http://www.safe.nite.go.jp/english/kizon/KIZON_start_hazkizon.html as of Sept 9, 2008.] **PEER REVIEWED**

Environmental Biodegradation :

AEROBIC: Soil slurry samples taken from three different Georgia watersheds were found to readily degrade alpha-pinene under aerobic conditions, undergoing complete removal within 250 hours after a short lag period(1,2). The concentration of alpha-pinene in seawater samples decreased from 0.41 ng/L to 0.25 ng/L when incubated with macrophytes for 6 hrs at 10 deg C(3). The concentration of alpha-pinene in the influent to

a kraft mill aerated stabilization basin with a 7-8 day retention time decreased from 0.20 ppm to 0.04 ppm(4). alpha-Pinene, present at 100 mg/L, reached 95% of its theoretical BOD in 4 weeks using an activated sludge inoculum at 30 mg/L in the Japanese MITI test(5).
[1) Misra G, Pavlostathis SG; Appl Microbiol Biotechnol 47: 572-7 (1997) (2) Misra G, Pavlostathis SG; Appl Microbiol Biotechnol 45: 831-8 (1996) (3) Button DK, Juttner F; Marine Chem 26: 57-66 (1989) (4) Hrutfiord BF et al; Tappi 58: 98-100 (1975) (5) Chemical Risk Information Platform (CHRIP). Biodegradation and Bioconcentration. Ver 2006.01.30 Updated. National Institute of Technology and Evaluation. Tokyo, Japan. alpha-Pinene (80-56-8). Available from the database query page at http://www.safe.nite.go.jp/english/kizon/KIZON_start_hazkizon.html as of Sept 9, 2008.] **PEER REVIEWED**

Environmental Water Concentrations :
SURFACE WATER: alpha-Pinene was detected, not quantified in the Black Warrior River, near Tuscaloosa, AL, 1975(1). The concentrations of alpha-pinene in seawater samples from Resurrection Bay, the south-central coast of Alaska, were 8,849 ng/L in June 1985 and 0.71 ng/L in June, 1986(2).
[(1) Bertsch W et al; J Chromatog 112: 701-18 (1975) (2) Button DK, Juttner F; Marine Chem 26: 57-66 (1989)] **PEER REVIEWED**

Atmospheric Concentrations :
URBAN/SUBURBAN: The average concn of alpha-pinene during a severe smog episode in Los Angeles, CA, 1993, was 0.70 ug/cu m(1). It was detected in < 10% of Atlanta air samples, 1992, at an avg concn of approx 100 ppb C(2). The concn of alpha-pinene in Riverside, CA, 1990, was 0.014-0.019 ug/cu m(3). During the TEAM study in Los Angeles, CA, 1987, 58.5% of outdoor air samples were found to contain alpha-pinene(4). alpha-Pinene was detected during 2 outdoor air sampling exercises taken in Los Angeles, CA, and in one outdoor sample from Pittsburg/Antioch County, CA, 1984, at estimated concentrations of 0.8 (Feb 1984) and 0.5 (May 1984) ug/cu m, and 0.1 (Jun 1984) ug/cu m, respectively(5) with median outdoor air concns ranging from 0.05-1.6 ug/cu m(6).
[(1) Fraser MP et al; Environ Sci Technol 31: 2356-67 (1997) (2) Bernardo-Bricker A et al; J Air Waste Manag Assoc 49: 591-603 (1995) (3) Helmig D, Arey, J; Sci Total Environ 112: 233-50 (1992) (4) Hartwell TD et al; Atmos Environ 26A: 1519-27 (1992) (5) Wallace LA et al; Atmos Environ 22: 2141-63 (1988) (6) Hartwell TD et al; Atmos Environ 21: 1995-2004 (1987)] **PEER REVIEWED**

Threshold Limit Values :
8 hr Time Weighted Avg (TWA): 20 ppm
[American Conference of Governmental Industrial Hygienists TLVs and BEIs. Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. Cincinnati, OH, 2008, p. 59] **PEER REVIEWED**

Special Reports :

The Flavor and Fragrance High Production Volume Consortia; Revised Robust Summaries for Bicyclic Terpene Hydrocarbons Submitted to the EPA under the HPV Challenge Program. 202 pp. (November 9, 2006). Available from a search of http://www.epa.gov/chemrtk/pubs/summaries/bictrphy/c13610tc.htm as of October **8**, 2008